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SPECIMEN EXAMINATION QUESTIONS IN JUNIOR HIGH SCHOOL ALGEBRA.

BY THE MATHEMATICS DEPARTMENT OF THE ETHICAL CULTURE HIGH
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PART I. NUMBER SYSTEMS.

I. Discuss briefly three number systems.

(a) State some distinguishing characteristic of each and show whether it is an advantage or disadvantage in each case.

(b) Mention some purposes for which the Roman numbers are used to-day.

II. State and illustrate any advantage you can think of in representing numbers by letters.

III. Illustrate some one or more advantages of extending the number system to include the negative number.

PART II. FORMULAS.

I. Western price list gives cost in cents per foot of sewer pipe $C \equiv 0.4d^2 + 14$, where d is diameter in inches. What would $\frac{1}{2}$ mile of 16 in. pipe cost?

II. The resistance r of a train in lbs. per ton, due to speed, is given by the formula $r \equiv 3 + (s/6)$. Construct a graph for speeds from 5 to 60 mi. per hr.

III. (a) Write in good English the following fact:

$$(a + b)^3 \equiv a^3 + b^3 + 3ab(a + b).$$

(b) Illustrate the fact stated in (a).

(c) Prove the fact stated in (a).

(d) What would be the effect on the cube of the sum of two numbers of doubling each number? Of tripling each number?

IV. If n gymnastic exercises may be taken in any order, the total number T of different ways in which they may be selected to follow each other is given by the statement:

$$T \equiv n(n - 1)(n - 2) \dots 3.2.1.$$

(a) In how many ways may a series of 5 exercises be arranged? 6 exercises? 7 exercises?

(b) Using the same formula in how many different ways may 8 people be seated in a row in the theater?

V. The formula for compound interest is

$$I = p \left(1 + \frac{r}{100} \right)^n - p,$$

where I is the interest, p the principal (in dollars), r the rate and n the number of years.

(a) What will be the compound interest on \$700 for 3 years at 4 per cent.?

(b) What principal will bring \$600 interest in two years at 10 per cent. compound interest?

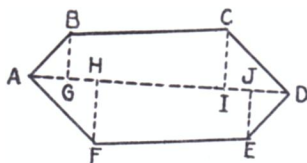
(c) Make a formula for the amount in a compound interest problem.

(d) To what will \$3,400 amount at 5 per cent. in 3 years?

(e) In a compound interest problem will the interest be doubled if the rate and time are unchanged but the principal doubled? Would the amount be doubled?

(f) Keeping the principal the same but doubling the rate (or time, keeping the other the same) would the interest (or amount) be doubled?

VI. In the polygon $ABCDEF$, $AG = a$; $GH = b$; $HI = c$; $IJ = d$; $JD = e$; $BG = f$; $HF = g$; $CI = h$; and $JE = k$. Write a formula for finding the area.



VII. Find the area of polygon in exercise VI if:

$$a = 100, \quad c = 400, \quad e = 150, \quad g = 200,$$

$$b = 100, \quad d = 100, \quad f = 150, \quad h = 175 \text{ and } k = 150.$$

VIII. The formula which transforms Fahrenheit readings of a thermometer into Centigrade readings is $C = \frac{5}{9}(F - 32)$. If $C = 40^\circ$, find the value of F .

1. Change the following readings to Fahrenheit readings:
(a) 0°C. , (b) 100°C. , (c) 50°C. , (d) -12°C.
 2. At what temperature do the Centigrade scale and Fahrenheit scale indicate equal numbers?
 3. Express F. in terms of C.
 4. Represent the original formula graphically.
 5. State in English the fact given in the original formula.
- IX. (a) A cone-shaped hood for a chimney is 30 in. in diameter and 13 in. high. Allowing 1 in. on the side for locking, what surface of metal is required for the hood?
- (b) Make a formula for use in solution of problems similar to 8.
- X. Represent by a diagram:

$$(a + b)^2 \equiv a^2 + 2ab + b^2.$$

$$\text{XI. } \begin{cases} 1 + 2 + 3 + 4 + \dots + n \equiv \frac{n}{2}(n + 1), \\ 1 + 3 + 5 + \dots + n \text{ terms} \equiv n^2, \\ 2 + 4 + 6 + \dots + n \text{ terms} \equiv n(n + 1), \\ (n + \frac{1}{2})^2 \equiv n(n + 1) + \frac{1}{4}. \end{cases}$$

Using above formulas

- (a) Find the sum of the first 600 odd numbers.
 - (b) Find the sum of the first 600 even numbers.
 - (c) Tabulate the squares of mixed numbers ending in one half from 50 to 60.
 - (d) In Italy the hours of the day are numbered from one to 24. How many strokes would a clock make per day in striking the hours?
 - (e) Find the sum of the first 600 numbers.
- XII. (a) Find the difference between the squares of the highest and lowest of three consecutive even numbers in terms of the numbers.
- (b) State the result as a general fact.
 - (c) Illustrate the fact.
 - (d) Is (c) true of odd numbers?

PART III. EQUATIONS—PROBLEMS.

- I. At what advance must a shopkeeper mark goods costing 90 cts. that he may allow a 20 per cent. discount and yet gain 25 per cent.?

II. The actual cost of removing a cubic yard of rock in excavating a certain canal is \$1.10. What price should be put in the estimate, if 12 per cent. is to be allowed for superintending and 10 per cent. on the cost, including superintending, is allowed for profit?

III. At Boston and New York (225 miles apart), the prices of coal are \$6.25 and \$6.75 respectively. Coal can be shipped for one half a cent per ton per mile. Find how far from Boston it will be indifferent to a customer whether he buys coal from Boston or New York.

IV. A house valued at \$8,000 rents for \$50 per month. The repairs on the house each year amount to \$80 and the taxes are \$100. No allowance being made for change in value, does the property pay, and if so what per cent?

V. If an ore loses $41\frac{1}{2}$ per cent. of its weight in roasting, and $43\frac{3}{4}$ per cent. of the remainder in smelting, how much ore will be required to yield 1,000 tons of metal?

VI. A tower casts a shadow of 20 ft. 6 in. when a man 5 ft. 8 in. high who is passing casts a shadow of 2 ft. 9 in. Find the height of the tower.

VII. A steamboat running at the rate of 8 miles an hour sees a motor boat 10 miles off, going at the rate of 5 miles per hour. How far will the steamboat go before it overtakes the motor boat? Solve by graph.

VIII. Two vessels sailed from the same point, one north at the rate of 15 knots an hour, the other east at the rate of 20 knots an hour. How far apart were they after 6 hours?

IX. A man going from a certain place traveled at the rate of 5 miles an hour. After he had been gone 3 hours, a horseman, going at the rate of 8 miles an hour, was sent after him. How far did the latter travel before overtaking the former?

X. (a) A factory has a fixed charge of \$20 daily, and makes an average gross profit of \$2 daily per workman employed. What remains after the fixed charge is paid is net profit. Make a graph showing how the net profit varies as the number of workmen varies from 0 to 50.

(b) A second factory has a fixed charge of \$60 and makes an average gross profit of \$3 daily per workman employed. Con-

struct a graph showing the net profits of this factory in the same diagram as (a).

(c) From the graph answer the following questions:

1. For what number of workmen will the factories make the same net profit?
2. What is that profit?
3. For what number of workmen does the first factory make the larger net profit?
4. For what number of workmen does the second factory make the larger net profit?
5. What number of workmen must each employ to make \$30 net profit?
6. What is the net profit of each factory if 25 workmen are employed?

PART IV. PROCESSES.

I. (a) State in words and algebraically one principle of addition.

(b) Subtract the sum of $5s^2 - 6s + 7$ and $10 - 6s - 4s^2$ from $s^2 - 6s + 16$.

(c) If $M \equiv 2a^3 - 3a^2b + ab$ and $N \equiv 3a^3 - 2a^2b - ab$ find $MN / -a^2$.

(d) Simplify: $m - (n - p) + [3m - \overline{3n - 6m}]$.

II. Solve, stating authorities:

$$22x - [3 - (3x - 2)] = 2x - (4x - 3) + 19.$$

III. Evaluate: $16 \times 3 \div 2 - 8 + 5 \times 2 - 9 \div 3 \times 6 - 12$.

IV. Divide $x^3 + 5x^2 - 8 - 13x$ by $x - 2$.

V. (a) Solve graphically: $x + 17y = 53$ and $8x + y = 19$.

(b) Check (a) by an algebraic solution.

VI. What is the coefficient of x in the reduced form of the expression

$$(x - 4a) - [2a - 3\{x - 2(x - a)\}]?$$

VII. Simplify:

$$\frac{5}{2 - a} + \frac{3}{a + 2} - \frac{1}{a^2 - 4}.$$

VIII. Simplify:

$$\frac{x^2 - 5x + 6}{x^2 + 3x + 2} \cdot \frac{x^2 + x - 2}{x^2 + x - 6} + \frac{x^2 - 4x + 3}{x^2 + 4x + 3}.$$

IX Solve for x :

$$\frac{x}{x-3} + \frac{1}{2(x^2 - x - 6)} = \frac{2}{x+2} + 1.$$

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